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PART II

AIRCRAFT GROUND-FLOTATION INVESTIGATION

PART II. DATA REPORT ON TEST SECTION 1

W. BRABSTON, A. RUTLEDGE, and W. HILL

U. S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION

TECHNICAL REPORT AFFDL-TR-66-43, PART II

APRIL 1966

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FOREWORD

The investigation described herein constitutes one phase of studies conducted during 1964 and 1965 at the U. S. Army Engineer Waterways Experiment Station (WES) under U. S. Air Force Project 410-A, MIPR No. AS-4-177, "Development of Landing Gear Design Criteria for the CX-HLS Aircraft." (The CX-HLS is now designated C-5A.) This program was sponsored and directed by the Landing Gear Group, Air Force Flight Dynamics Laboratory, Research and Technology Division, Mr. R. J. Parker, Project Engineer.

These tests were conducted by personnel of the WES Flexible Pavement Branch, Soils Division, under the general supervision of Messrs. W. J. Turnbull, A. A. Maxwell, and R. G. Ahlvin, and the direct supervision of Mr. D. N. Brown. Other personnel actively engaged in this study were Messrs. C. D. Burns, D. M. Ladd, W. N. Brabston, A. H. Rutledge, H. H. Ulery, Jr., A. J. Smith, Jr., and W. J. Hill, Jr. This report was prepared by Messrs. Brabston, Rutledge, and Hill.

Directors of WES during the conduct of this investigation and preparation of this report were Col. Alex G. Sutton, Jr., CE, and Col. John R. Oswalt, Jr., CE. Technical Director was Mr. J. B. Tiffany.

Publication of this technical documentary report does not constitute Air Force approval of the report's findings or conclusions. It is published only for the exchange and stimulation of ideas.

FOR THE DIRECTOR

GEORGE A. SOLT, JR.
Actg Chief, Mechanical Branch
Vehicle Equipment Division
AF Flight Dynamics Laboratory

ABSTRACT

This data report describes work undertaken as part of an overall program to develop ground-flotation criteria for the C-5A aircraft. A test section was constructed to a width adequate for two test lanes. Each lane was divided into three items having different subgrade CBR values. Two items were unsurfaced, and the remaining item was surfaced with modified T11 aluminum landing mat. Traffic was applied to the lanes using a 104,000-lb load on a twin-wheel assembly consisting of two 56.00-16, 36-ply aircraft tires with inflation pressure of 200 psi. Wheel spacing was 37 in. c-c for one lane and 24 in. c-c for the other.

This report presents the data collected on soil strengths, surface deformations and deflections, and drawbar pull. The traffic-coverage level at which failure was evidenced on each test item is also given.

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SUMMARY

Tests on Section 1 are one phase of a comprehensive research program to develop ground-flotation criteria for heavy cargo-type aircraft. Section 1 consisted of two similar traffic lanes, lanes 1 and 2, each of which was divided into three items (**Fig 18**). Each item was constructed to a different subgrade CBR value. Items 1 and 2 were unsurfaced, and item 3 (**Fig 19**) was surfaced with modified T11 aluminum landing mat.

Traffic was applied to the two lanes using a twin-wheel assembly with 200-psi tire inflation pressures and 104,000-lb test load. As used in both lanes, the wheel assembly consisted of two 56.00-16, 36-ply aircraft tires spaced 37 in. c-c and 24 in. c-c for trafficking lanes 1 and 2, respectively. **Fig 20** gives pertinent tire print dimensions and tire characteristics. The lanes were trafficked to failure in accordance with the criteria designated in Part I of this report. Data were recorded throughout testing to give a behavior history of each item.

Using the test criteria mentioned above it was possible to directly compare the effects of trafficking with the two assemblies. Basic performance data are summarized in the following paragraphs.

Lane 1

Item 1

The average subgrade CBR for the top 12 in. of soil was 10 prior to traffic. Two passes of the test vehicle produced severe rutting and failure of the item due to excessive roughness.

Item 2

The average subgrade CBR for the top 12 in. of soil was 15 prior to traffic. Traffic was suspended at 300 coverages without reaching a failure condition on the item because the subgrade CBR was increasing with traffic (30 CBR after 300 coverages). The surface was slightly rutted, but the overall condition of the item was good. The rated CBR for the item was 27.

Item 3

Item 3 was surfaced with modified T11 aluminum landing mat. Failure of the item occurred at 300 coverages due to roughness and general mat deterioration. The rated CBR for the item was 7.4.

Lane 2

Item 1

The average subgrade CBR for the top 12 in. of soil was 10 prior to traffic. As in item 1 of lane 1, two passes of the test vehicle produced severe rutting and failure of the item due to excessive roughness.

Item 2

The item was considered failed at 130 coverages due to excessive roughness. Some CBR increase occurred in the item with trafficking (average CBR values of 15 and 22 at 0 and 130 coverages, respectively). The rated CBR for the item was 18.

Item 3

Item 3 was surfaced with modified T11 aluminum landing mat. The item was considered failed after 40 coverages due to roughness and mat deterioration. The rated CBR for the item was 8.7.

AIRCRAFT GROUND-FLOTATION INVESTIGATION

PART II DATA REPORT ON TEST SECTION 1

SECTION I: INTRODUCTION

The investigation reported herein is one phase of a comprehensive research program being conducted at the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss., as part of U. S. Air Force Project 410-A, MIPR No. AS-4-177, to develop ground-flotation criteria for the C-5A, a heavy cargo-type aircraft. Specifically, the tests reported herein are part of a series of tests to determine the degree of interaction of the wheels of multiple-wheel landing-gear assemblies with landing mat and unsurfaced soils under various conditions of loading.

Prosecution of this investigation consisted of constructing two similar traffic lanes and subjecting them to equal test loads with twin-wheel landing-gear assemblies using different wheel spacings for the two lanes.

This report presents a description of the test section and wheel assemblies, and gives results of traffic. Equipment used, types of data and method of recording them, and general test criteria are explained and illustrated in Part I of this report.

SECTION II: DESCRIPTION OF TEST SECTION AND LOAD VEHICLE

Description of Test Section

The test section (**Fig 18**) was located within a roofed area in order to allow control of the subgrade CBR (California Bearing Ratio) in the test items. Construction of the test section was accomplished by first excavating a 54- by 80-ft area to a depth of 24 in. The excavated area was backfilled to the original grade level in compacted lifts with a heavy clay soil (classified as CH according to the Unified Soil Classification System). The fill material used was a local clay (buckshot) with a plastic limit of 27, liquid limit of 58, and plasticity index of 31. Gradation and classification data for the subgrade material are given in Part I. The surface of the section was graded and then smoothed by rolling with a 10-ton steel-wheel roller.

Two 12-ft-wide traffic lanes divided into three items each were constructed in the section. Different subgrade strengths were obtained in the items (**Fig 18**) by controlling the water content and compaction effort. Items 1 and 2 were unsurfaced, and item 3 (**Fig 19**) was surfaced with modified T11 aluminum landing mat which was embedded in the subgrade by rolling with a 70,000-lb rubber-tired roller. The landing mat used is described and illustrated in Part I.

Load Vehicle

The load vehicle is shown in **Figure 17.** Details of construction and linkage of the load compartment and prime mover are given in Part I. For trafficking lanes 1 and 2, the load compartment was weighted to produce a load of 104,000 lb on a twin-wheel tracking assembly. For trafficking, the load wheels were spaced 37 and 24 in. c-c for lanes 1 and 2, respectively. Two 56.00-16, 36-ply, type VII aircraft tires with tire inflation pressure of 200 psi were used on the wheels. Tire-print data and pertinent tire characteristics are given in **Figure 20.**

SECTION III: APPLICATION OF TRAFFIC AND FAILURE CRITERIA

Application of Traffic

The load vehicle was operated to produce uniform traffic coverage on the test lanes. The load cart was driven forward and backward along the same track longitudinally along the test lane, then shifted laterally, and the forward-backward operation repeated. Positions 1, 2, and 3 were trafficked; the cart was then shifted and positions 4, 5, and 6 were trafficked. In this manner, two coverages of traffic were applied to the test lane as the vehicle progressed from one side of the lane to the other. Figure 1 shows the general method of applying uniform coverages on the test lanes.

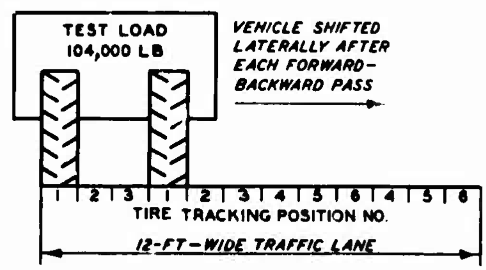


Figure 1. Sequence of traffic application for uniform coverages

Typically, the lane widths used were not exact multiples of the tracking tire widths and spacings so that it was necessary to determine a coverage factor for each lane to compensate for small overlaps or gaps in the coverage pattern. In all cases, the coverage levels indicated in the text and on the data sheets represent the coverage levels determined in this fashion.

Failure Criteria

Failure criteria used in this investigation and descriptive terms used in presentation and discussion of data in all reports in this series are presented in Part I. A general outline of types of data collected is given in the following paragraphs. Details on apparatus and procedure for obtaining specific measurements are given in Part I.

CBR, water content, and dry density

CBR, water content, and dry density of the subgrade soil were measured for each test item prior to application of traffic, at intermediate coverage levels, and at failure or suspension of traffic if no failure condition was reached. After traffic was concluded on an item, a measure of subgrade strength termed "rated CBR" was determined. Rated CBR is generally the average CBR value obtained from all the determinations made in the top 12 in. of soil during the test life of an item. In certain

instances, extreme or irregular values may be ignored if the analyst decides that they are not properly representative.

Surface roughness, or differential deformation

Surface roughness, or differential deformation, measurements were made using a 10-ft straightedge at various traffic-coverage levels on all items. Rut depths were measured for unsurfaced items, and dishing effects of individual mat panels in the mat-surfaced items were recorded.

Deformations

Deformations, defined as permanent cumulative surface changes in cross section or profile of an item, were charted by means of level readings at pertinent traffic-coverage levels.

Deflection

Deflection of the test surface under an individual static load of the load-wheel assembly was measured at various traffic-coverage levels on both mat-surfaced and unsurfaced items. Level readings on the item surface on each side of the load wheels and on a pin and cap device directly beneath a load wheel provided deflection data. Both total (for one loading) and elastic (recoverable) deflections were measured on unsurfaced items. All mat deflection was for practical purposes recoverable, i.e. total deflection equaled elastic (spring-back) deflection. Subgrade deflection (both total and elastic) directly beneath load wheels was determined at intervals by utilizing a pin and cap device, as illustrated in Part I. The pin and cap device was applied to the subgrade of surfaced items through a hole (existing or cut) in the mat.

Rolling resistance

Rolling resistance, or drawbar pull, measurements were performed with the load vehicle over each test item at designated coverage levels. Three types of drawbar measurement were taken: (a) maximum force required to overcome static inertia and commence forward movement of the load cart, termed "initial DBP"; (b) average force required to maintain a constant speed once the load vehicle is in motion, termed "rolling DBP"; and (c) maximum force obtained during the constant speed run, termed "peak DBP."

Mat breaks

Mat breaks on the surfaced items were inspected, classified by type, and recorded on the data sheet at various coverage levels.

SECTION IV: BEHAVIOR OF ITEMS UNDER TRAFFIC AND TEST RESULTS

Lane 1

Behavior of items under traffic

Item 1. The average subgrade CBR was 10 for the top 12 in. of soil in item 1 prior to traffic. The test vehicle caused severe rutting after two passes made in an attempt to record 0-coverage drawbar pull values. Rut depths exceeded 6 in., and the item was considered failed at two passes (**Figure 2**).

Item 2. The average subgrade CBR was 15 for the top 12 in. of soil in item 2 prior to traffic. Slight rutting of the surface resulted from two passes of the load vehicle during 0-coverage drawbar pull tests. After 20 coverages, the entire item had depressed in the tracked lane approximately 1 in. and the surface was relatively flat and in very good condition (**Figure 3**) . A reduced rate of soil depression continued throughout the traffic period. At 40 coverages, the average CBR had increased to 34 for the top 12 in. of soil. Slight rutting of the surface was evident when traffic was suspended at 300 coverages, but the overall condition of the item remained good (**Figure 4**) and it was not considered failed. The traffic was discontinued because the CBR was increasing with traffic, and an excessive amount of time would have been required to develop a failure. The rated CBR of the item was 27 after 300 coverages of the test vehicle.

Item 3. Item 3 prior to traffic is shown in **Figure 5.** After 20 coverages, there were slight differential mat deformations along with an initial soil depression of about 1 in. No significant mat damage was evident with continued traffic to 100 coverages. At 135 coverages, sheared rivets and increasing differential deformations were noted. At 200 coverages, cracks appeared in the mat surface, but the item remained in serviceable condition. Traffic was continued to 300 coverages, at which time the mat was considered failed due to excessive roughness and mat deterioration (**Figures 6 and 7**). The rated CBR for the item was 7.4.

Test results

Table 1 summarizes traffic data recorded on each item of lane 1 during testing. Soil test data are given in table 2.

Item 1. No uniform traffic coverage was possible on item 1, as failure due to severe rutting occurred during preliminary passes made for drawbar pull measurements. The values recorded for drawbar pull are shown in table 1. A cross-section plot showing average soil deformation at failure is shown in **Figure 21.**

Item 2. Traffic was suspended at 300 coverages without reaching a failure condition on item 2. Average CBR values in the top 12 in. of soil increased with application of traffic. The following information was obtained from traffic tests on item 2.

a. Roughness. The maximum average differential deformation (transverse) attained was 1.60 in. with no severe ruts developing. Differential deformation measurements at various coverage levels throughout the test are presented in table 1 along with rut measurements.

b. Deformation. Average soil deformation increased uniformly during trafficking. A maximum average deformation of 3.3 in. was measured at 300 coverages when traffic was suspended. **Figs 21 and 22** show average cross-section and profile surface deformations at various coverage levels.

c. Deflections. Average total soil deflections (total for one loading) are shown in **Fig 23.** Maximum deflections under the load wheels were 1.0 and approximately 0.5 in. at 0 and 300 coverages, respectively. Elastic soil deflection was 0.1 and approximately 0.4 in. at 0 and 300 coverages, respectively.

d. Rolling resistance. Initial, peak, and rolling drawbar pull values (table 1) decreased during the first 135 coverages. Thereafter, initial and peak drawbar pull increased, and at 300 coverages the values exceeded those recorded at 0 coverages. Rolling drawbar pull increased slightly from 135 to 300 coverages, but never equaled the 0-coverage value.

Item 3. Item 3 was considered failed due to roughness at 300 coverages. The following information was obtained from traffic tests on item 3.

a. Roughness. At 300 coverages, longitudinal, transverse, and diagonal differential deformations were 2.00, 1.75, and 2.25 in., respectively (see table 1).

b. Deformation. Mat deformations are shown in **Fig 21.** The mat cross section progressively assumed a trough shape as trafficking proceeded, reaching a maximum deformation of 2.8 in. Development of longitudinal deformation is indicated in **Fig 22.** The maximum deformation measured along this direction was 3.0 in.

c. Deflection. Deflection of the mat under the load wheels increased to the 200-coverage level and decreased thereafter. The maximum deflection of 2.3 in. occurred with the wheel assembly centered over panel joints. **Fig 23** shows deflections measured with the wheel assembly in several positions relative to the mat joints.

d. Embedment. The mat within the limits of the traffic lane was almost fully embedded in the subgrade after 300 coverages.

e. Rolling resistance. Drawbar pull values (table 1) showed an increase up to the 135-coverage level and remained relatively unchanged thereafter.

Lane 2

Behavior of items under traffic

Item 1. Item 1 prior to traffic is shown in **Figure 8.** The average subgrade CBR for the top 12 in. of soil in item 1 was 10 prior to traffic. The test vehicle caused severe rutting after two passes were made in an attempt to record 0-coverage drawbar pull values. Rut depths exceeded 4 in., and the item was judged failed at two passes **Figure 9.**

Item 2. Item 2 prior to traffic is shown in **Figure 10.** Except at the transition between item 2 and the previously failed item 1, the item showed no severe distress prior to 100 coverages, but it deteriorated rapidly thereafter. At 130 coverages the item was considered failed due to roughness and shear deformation in the soil (**Figure 11**). A slight increase in CBR (from 15 CBR to 22 CBR) occurred with trafficking. The rated CBR of the item was 18.

Item 3. Item 3 prior to traffic is shown in **Figure 12.** At 20 coverages, rivet breakage had begun, and there was evidence of subgrade material being extruded upward through the joints of the mat. The greatest rivet damage was along the center lines of the individual mat panels. At 40 coverages, item 3 was considered failed due to roughness and mat deterioration (**Figures 13 and 14**). The rated CBR of the item was 8.7.

To observe the rate of mat deterioration under postfailure conditions, an additional 28 coverages of traffic were applied to item 3. Severe mat damage was rapid, and panels separated along their center lines (**Figure 15**). Shearing of drive rivets in end connectors occurred just outside the traffic lane, allowing the panel end joints to open (**Figure 16**). At 68 coverages, movement of the load vehicle over the item had become difficult, and traffic was suspended.

Test results

Table 1 summarizes traffic data recorded on each item of lane 2 during testing. Soil test data are given in table 2.

Item 1. No uniform traffic coverage was possible on item 1, as failure due to severe rutting occurred during preliminary passes of the load vehicle. The only data recorded were the 0-coverage drawbar pull values and rut depth shown in table 1.

Item 2. Item 2 was considered failed due to roughness at 130 coverages of the test vehicle. The following information was obtained from traffic tests on item 2.

a. Roughness. At failure, the maximum transverse and diagonal differential deformations (table 1) were 3.38 and 3.13 in., respectively.

b. Deformation. Average cross section and profile deformation plots are shown in **Figures 21 & 22**, respectively. A maximum average cross-section deformation of 3.5 in. was measured at failure. Along the center-line profile, maximum average deformation was 3.2 in. Rutting in item 2 was more pronounced on the south end adjoining the previously failed item 1 due to progression of ruts from the transition.

c. Deflection. Total soil deflections under the load wheels are shown in **Fig 23.** Maximum total deflection of about 0.7 in. was measured beneath the load wheels at 130 coverages. Maximum elastic soil deflection (table 1) was 0.4 in. at 130 coverages.

d. Rolling resistance. Drawbar pull values were recorded at 0 and 130 coverages (table 1). At failure, the initial drawbar pull value showed an increase of about 2 kips over the 0-coverage value. Peak and rolling drawbar pull values were less at failure than at 0 coverages.

Item 3. Item 3 was considered failed due to roughness at 40 coverages, but traffic was continued for 28 postfailure coverages. The following information was obtained from traffic tests on item 3.

a. Roughness. At failure the maximum longitudinal, transverse, and diagonal differential deformations (table 1) were 2.25, 1.75, and 2.31 in., respectively.

b. Deformation. Average cross-section deformation plots are shown in **Fig 21**. A maximum deformation of 2.0 in. was measured at failure. A profile deformation plot is shown in **Figure 22.**

c. Deflection. Deflection of the mat under the load wheels increased throughout traffic. The maximum average deflection of 3.4 in. occurred at failure with the wheel assembly centered over panel joints. **Fig 23** shows deflections with the wheel assembly in several positions relative to mat joints. Each of these deflection plots reflects a smooth, concave cross section. Elastic subgrade deflection at failure was 1.8 in. After 28 postfailure coverages, the elastic subgrade deflection was 1.7 in.

d. Rolling resistance. Initial, peak, and rolling drawbar pull values (table 1) recorded at 40 coverages showed significant increases over values measured at 0 coverages.

SECTION V: PRINCIPAL FINDINGS

From the foregoing discussion, the principal findings relating test load, wheel assembly, tire inflation pressure, surface type, subgrade CBR, and traffic coverages are as follows:

Load, Wheel Assembly, and Tire Pressure	Type of Surface	Rated Subgrade CBR	Coverages at Failure
104,000-lb load; twin-wheel assembly; 37-in. c-c, 56.00-16, 36-ply tires at 200-psi inflation pressure	Unsurfaced	10	2 passes
	Unsurfaced	27	No failure; traffic suspended at 300 coverages
	Modified T11 aluminum mat	7.4	300
104,000-lb load; twin-wheel assembly; 24-in. c-c, 56.00-16, 36-ply tires at 200-psi inflation pressure	Unsurfaced	10	2 passes
	Unsurfaced	18	130
	Modified T11 aluminum mat	8.7	40

TABLE 1

SUMMARY OF TRAFFIC DATA, TEST SECTION 1

Test Item	Coverages	Rated CBR	No. of Mat Breaks* A	No. of Mat Breaks* B	No. of Mat Breaks* C	No. of Mat Breaks* D	No. of Mat Breaks* E	Maximum Differential Deformation (in.) Longitudinal	Maximum Differential Deformation (in.) Transverse	Maximum Differential Deformation (in.) Diagonal	Max Dishing or Rutting (in.)	Drawbar Pull (kips) Initial	Drawbar Pull (kips) Peak	Drawbar Pull (kips) Rolling	Average Total Deflection (in.) with ℄ of Assembly Located on: Unsurfaced Item Max	Unsurfaced Item Center Line of Assembly	Quarter Point of Panel Max	Quarter Point of Panel Center Line of Assembly	Half Point of Panel Max	Half Point of Panel Center Line of Assembly	Joint of Panel Max	Joint of Panel Center Line of Assembly	Elastic Subgrade Deflection (in.)	Remarks
Lane 1																								
1 Unsurfaced	0	10	--	--	--	--	--	--	--	--	--	13.0	19.0	10.5	--	--	--	--	--	--	--	--	--	Failed at two passes. No uniform coverage applied
	2 passes		--	--	--	--	--	--	6.40	--	6+	--	--	--	--	--	--	--	--	--	--	--	--	
2 Unsurfaced	0	27	--	--	--	--	--	--	--	--	--	10.3	11.5	4.9	1.1	0.2	--	--	--	--	--	--	0.1	Traffic suspended at 300 coverages. Item did not fail
	20		--	--	--	--	--	--	0.63	--	--	--	--	--	0.4	0.2	--	--	--	--	--	--	0.1	
	40		--	--	--	--	--	--	--	--	--	--	--	--	0.5	0.2	--	--	--	--	--	--	0.3	
	100		--	--	--	--	--	0.94	1.10	0.75	--	--	--	--	0.5	0.2	--	--	--	--	--	--	0.4	
	135		--	--	--	--	--	--	--	--	--	10.0	9.3	3.4	--	--	--	--	--	--	--	--	--	
	200		--	--	--	--	--	0.25	1.25	0.88	--	--	--	--	0.2	0.3	--	--	--	--	--	--	0.1	
	300		--	--	--	--	--	0.25	1.60	1.44	1.68	11.5	13.5	3.6	0.2	0.2	--	--	--	--	--	--	0.4	
3 Modified T11 aluminum landing mat	0	7.4	--	--	--	--	--	--	--	--	--	9.5	15.0	4.6	--	--	1.5	1.3	1.6	1.3	1.6	1.3	--	Item failed at 300 coverages
	20		--	--	--	--	--	0.50	0.69	0.75	--	--	--	--	--	--	1.9	1.7	2.0	1.9	2.0	2.0	--	
	100		--	--	--	--	--	1.00	1.00	0.88	--	--	--	--	--	--	--	1.7	--	1.7	--	2.1	--	
	135		--	13	3	--	--	--	--	--	--	10.8	15.5	5.8	--	--	--	--	--	--	--	--	--	
	200		11	28	8	--	--	1.50	1.44	1.36	--	--	--	--	--	--	2.2	2.0	2.1	1.9	2.3	2.3	--	
	300		18	68	29	--	22	2.00	1.75	2.25	--	10.8	15.2	5.8	--	--	2.0	1.7	1.8	1.7	2.0	1.9	--	
Lane 2																								
1 Unsurfaced	0	10	--	--	--	--	--	--	--	--	--	19.0	12.0	7.6	--	--	--	--	--	--	--	--	--	Failed at two passes. No uniform coverage applied
	2 passes		--	--	--	--	--	--	--	--	4+	--	--	--	--	--	--	--	--	--	--	--	--	
2 Unsurfaced	0	18	--	--	--	--	--	--	--	--	--	11.2	9.2	4.7	--	--	--	--	--	--	--	--	0.2	Failed at 130 coverages due to excessive roughness
	20		--	--	--	--	--	0.75	1.12	1.25	--	--	--	--	0.5	0.4	.	--	--	--	--	--	0.2	
	30		--	--	--	--	--	0.81	1.06	1.19	--	--	--	--	--	--	--	--	--	--	--	--		
	40		--	--	--	--	--	0.63	1.19	1.50	--	--	--	--	--	--	--	--	--	--	--	--	0.5	
	100		--	--	--	--	--	0.44	1.50	1.50	--	--	--	--	--	--	--	--	--	--	--	--	0.2	
	130		--	--	--	--	--	0.88	3.38	3.13	3.4	13.5	7.2	4.5	0.7	0.5	--	--	--	--	--	--	0.4	
3 Modified T11 aluminum landing mat	0	8.7	--	--	--	--	--	--	--	--	--	11.5	7.7	4.7	--	--	1.7	1.7	1.8	1.8	2.1	2.1	--	Failed at 40 coverages. Traffic continued for 28 post-failure coverages
	20		--	1	27	1	--	1.00	1.31	1.50	0.50	--	--	--	--	--	2.4	2.4	2.2	2.2	2.8	2.8	--	
	30		2	10	90	1	--	1.88	1.38	1.88	0.88	--	--	--	--	--	--	--	--	--	--	--		
	40		2	29	111	1	--	2.25	1.75	2.31	0.94	14.0	10.8	6.3	--	--	2.7	2.7	2.5	2.5	3.4	3.4	1.8	
	68		--	--	--	--	--	--	3+	--	--	--	--	--	--	--	--	--	--	--	--	--	1.7	

Note: A 104,000-lb load on a twin-wheel assembly was used for trafficking. On the wheels were 56-16, 36-ply aircraft tires inflated to 200 psi. Wheel spacings were 37 in. c-c for lane 1 and 24 in. c-c for lane 2.

* Break types are defined and illustrated in Part I.

TABLE 2

SUMMARY OF CBR, DENSITY, AND WATER CONTENT DATA, TEST SECTION 1

Test Item*	Type of Surface	Number of Traffic Coverages	Depth (in.)	CBR	Water Content (%)	Dry Density (lb/cu ft)	Remarks
				Lane 1			
1	Unsurfaced	0	0	10	24.8	95.8	Item failed at two passes due to severe rutting
			6	9	21.9	100.6	
			12	11	22.0	97.7	
			18	7	24.0	97.5	
2	Unsurfaced	0	0	14	18.5	93.9	Traffic suspended at 300 coverages. Item did not fail
			6	15	16.2	96.1	
			12	16	17.6	94.3	
			18	17	21.0	101.1	
		40	0	45	17.9	108.5	
			6	38	17.5	108.1	
			12	19	20.9	102.7	
		200	0	40	17.4	110.1	
			6	31	18.5	108.1	
			12	14	20.9	104.5	
		300	0	39	17.6	109.2	
			6	31	17.0	110.0	
			12	20	19.3	105.8	
3	Modified T11 aluminum landing mat	0	0	7	24.7	95.3	Item failed due to roughness at 300 coverages
			6	7	22.4	99.4	
			12	7	21.4	101.8	
			18	6	24.2	97.8	
		200	0	9	23.2	99.6	
			6	6	23.1	101.1	
			12	6	23.3	100.1	
			18	7	25.3	96.7	
		300	0	8	21.0	102.4	
			6	8	21.2	103.2	
			12	9	20.9	103.5	
				Lane 2			
1	Unsurfaced	0	0	10	24.3	96.5	Item failed at two passes due to severe rutting
			6	12	21.0	101.8	
			12	9	22.8	98.9	
2	Unsurfaced	0	0	14	19.0	96.1	Item failed at 130 coverages due to rutting
			6	15	17.3	96.0	
			12	15	19.3	99.7	
		130	0	22	17.6	107.4	
			6	24	17.2	108.7	
			12	21	19.5	105.0	
3	Modified T11 aluminum landing mat	0	0	8	26.2	94.2	Item failed at 40 coverages due to roughness. Traffic continued for 28 post-failure coverages
			6	10	21.4	101.0	
			12	9	21.6	102.0	
		40	0	9	24.2	99.8	
			6	8	21.1	101.6	
			12	8	21.1	101.6	
		68	0	8	25.6	100.4	
			6	9	21.9	101.4	
			12	8	22.7	100.8	

* Subgrade material was heavy clay (classified as CH) in all items.

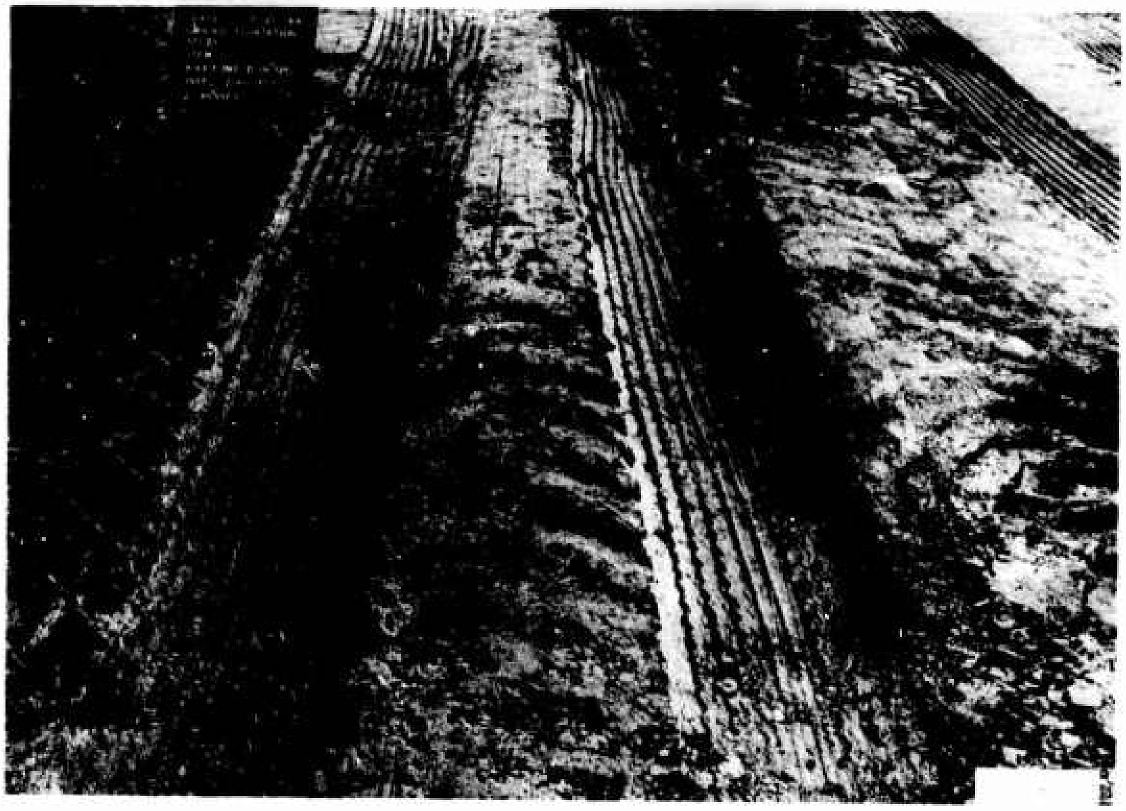


Figure 2. Lane 1, item 1, at two passes (failure)

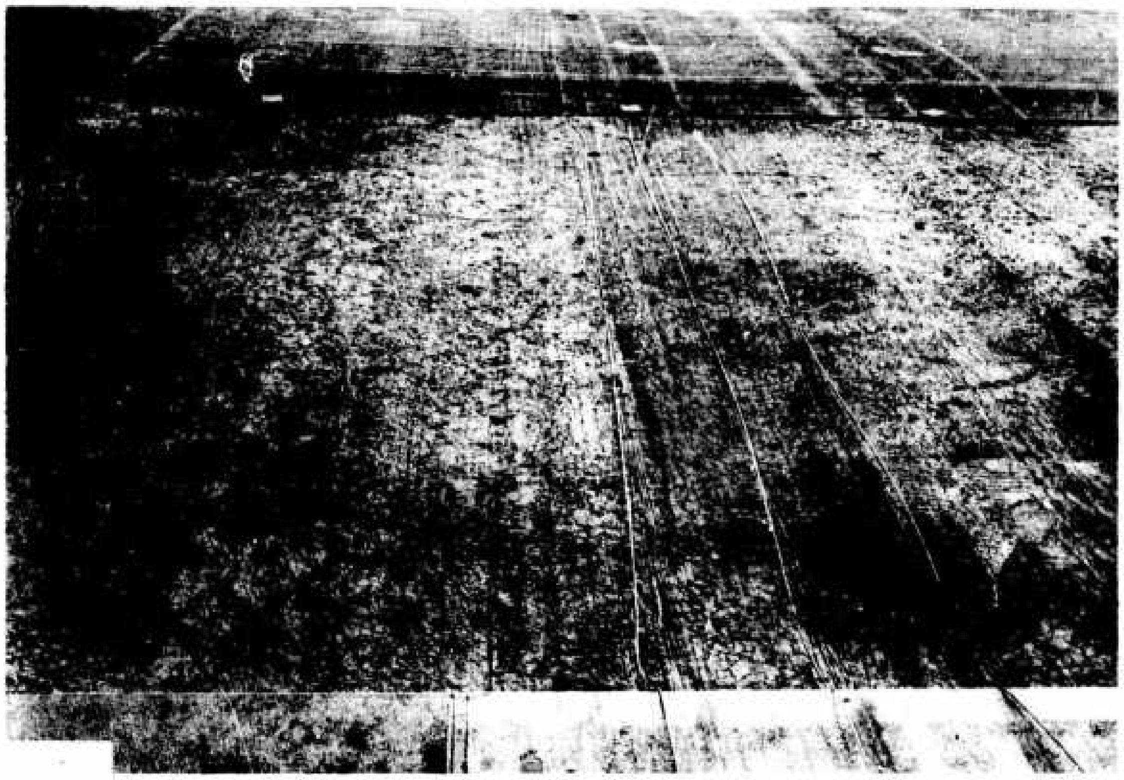


Figure 3. Lane 1, item 2, at 20 coverages

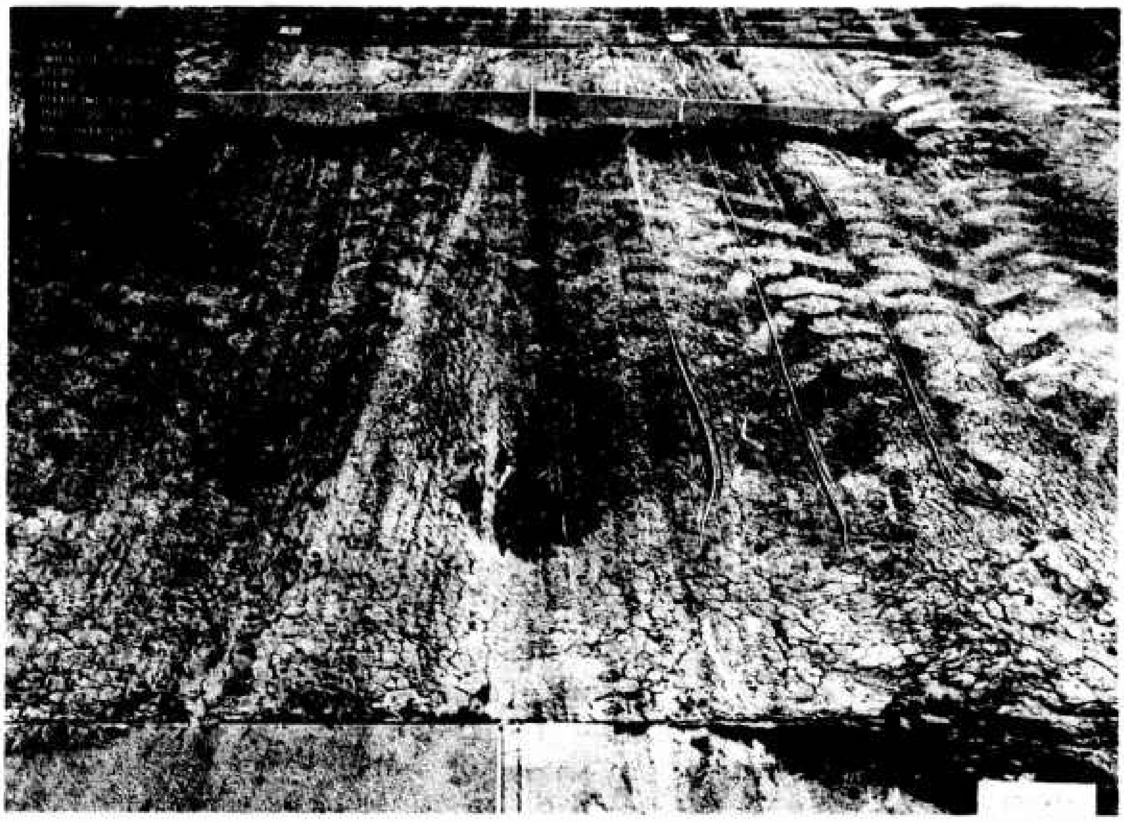


Figure 4. Lane 1, item 2, at 300 coverages (traffic suspended, no failure)

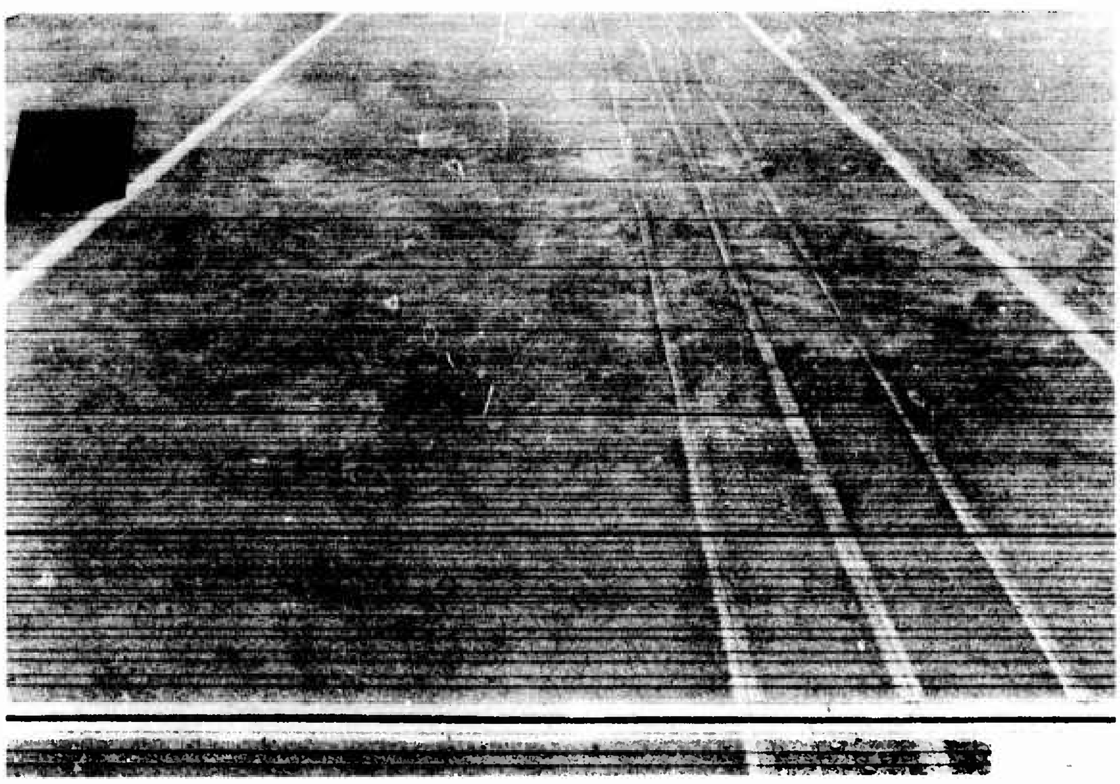


Figure 5. Lane 1, item 3, prior to traffic

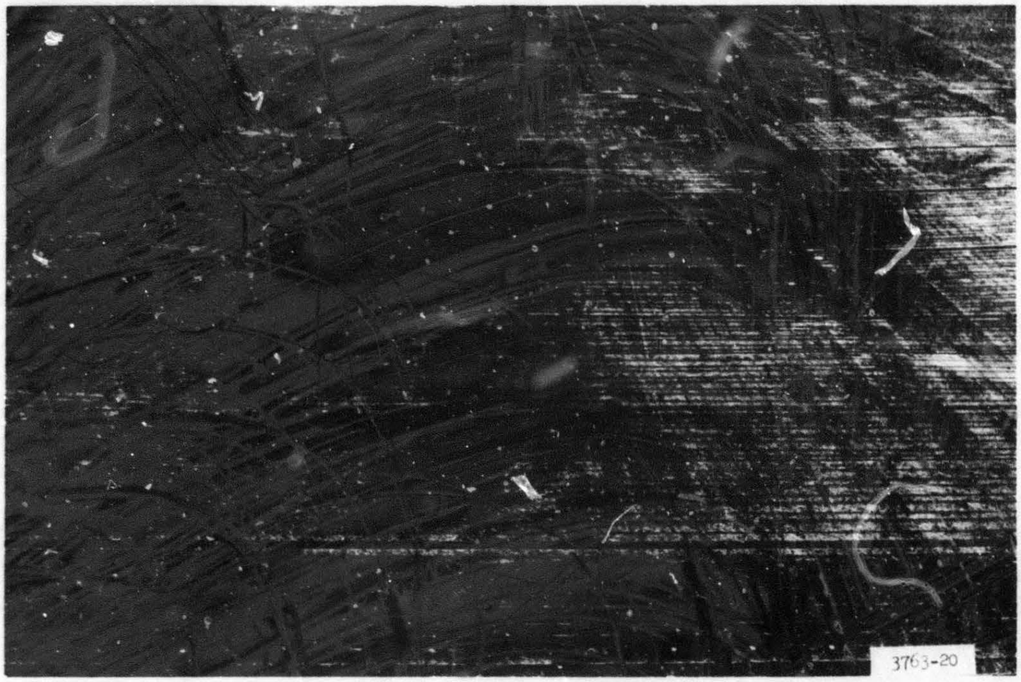


Figure 6. Lane 1, item 3, at 300 coverages (failure). Transverse straightedge shows roughness

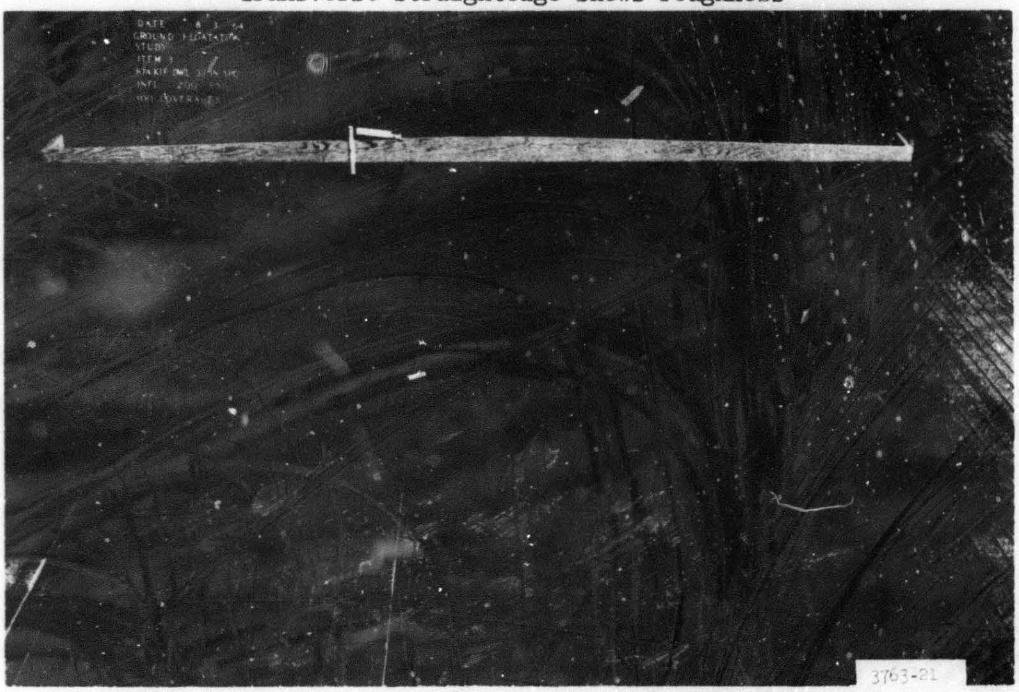


Figure 7. Lane 1, item 3, at 300 coverages (failure). Longitudinal straightedge shows deformation

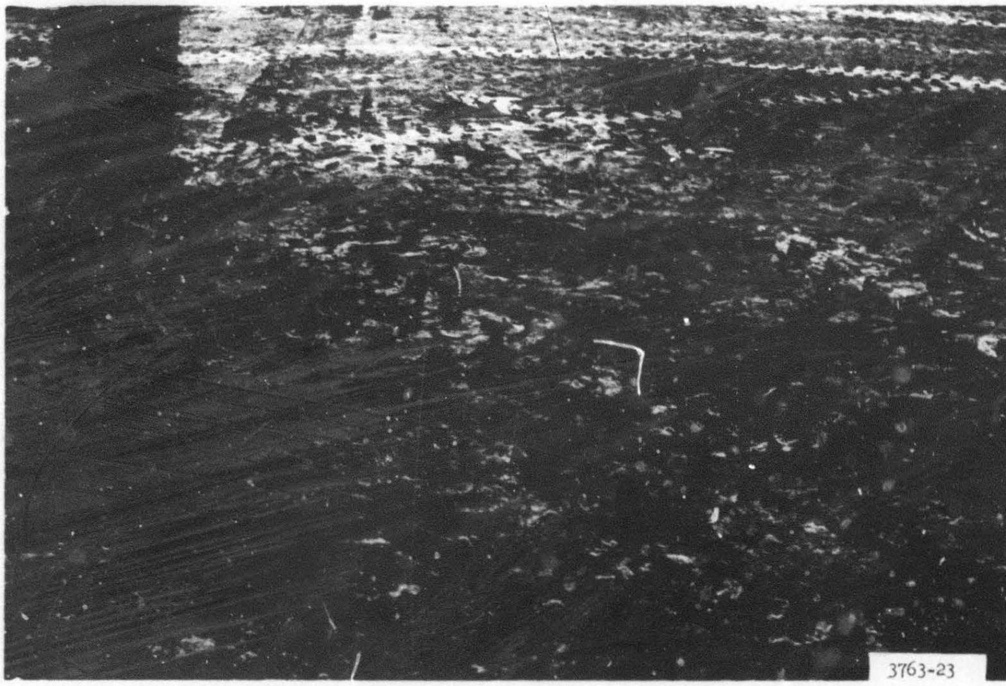


Figure 8. Lane 2, item 1, prior to traffic

Figure 9. Lane 2, item 1, at two passes (failure)

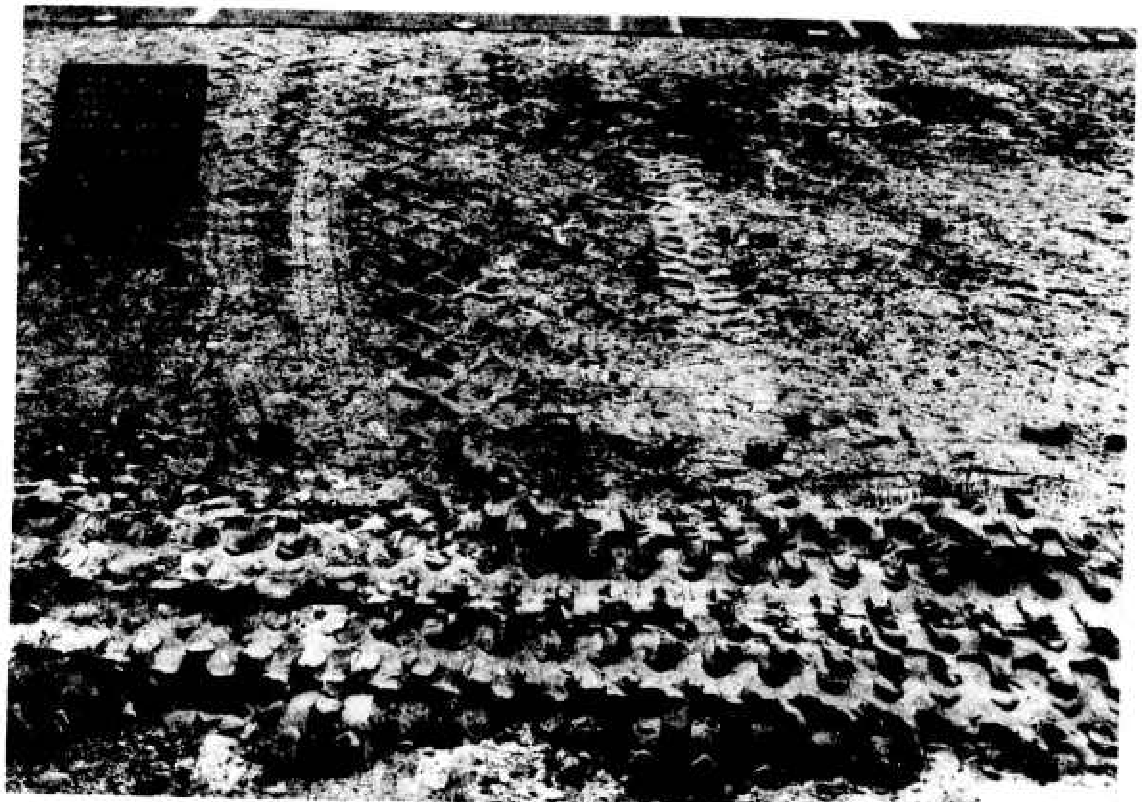


Figure 10. Lane 2, item 2, prior to traffic

3763-36

Figure 11. Lane 2, item 2, at 130 coverages (failure)

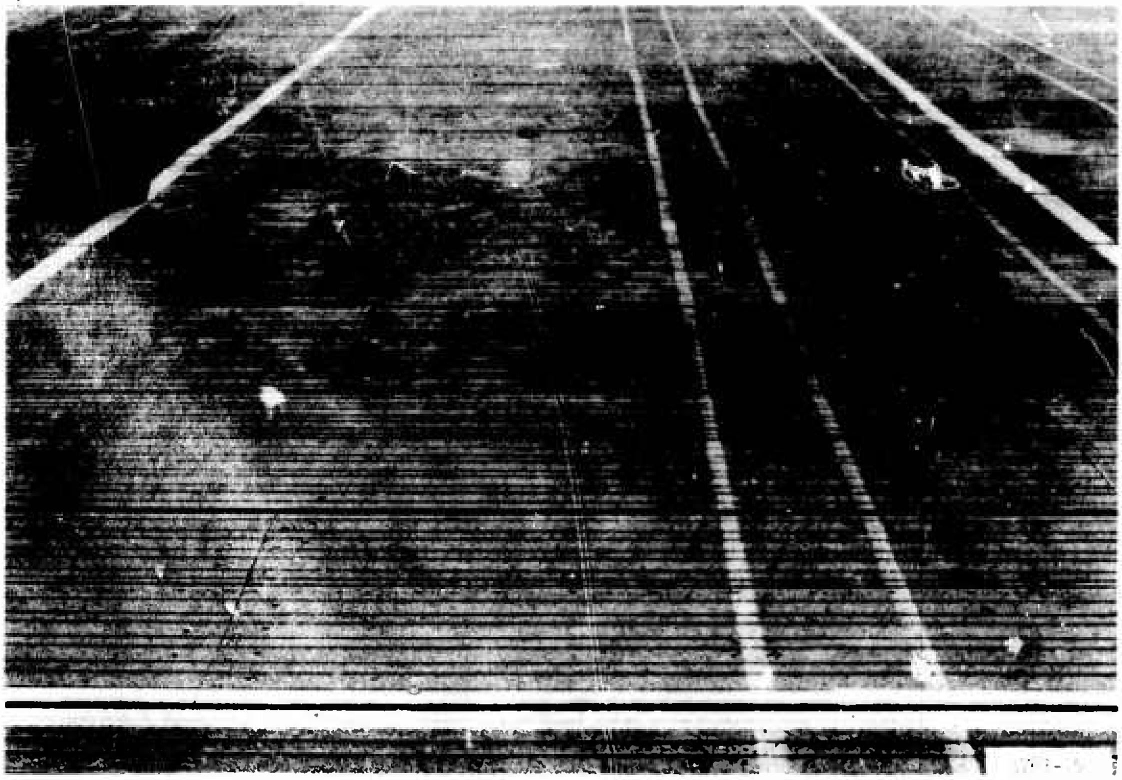


Figure 12. Lane 2, item 3, prior to traffic

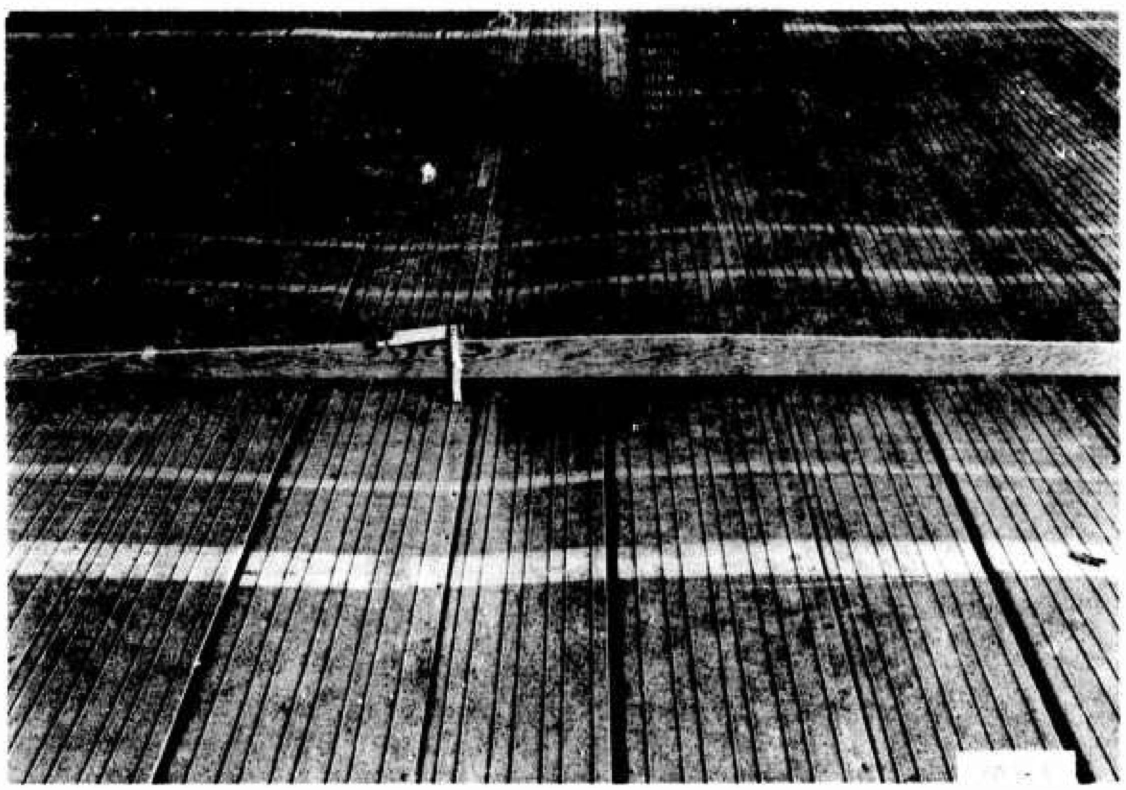


Figure 13. Lane 2, item 3, at 40 coverages (failure). Longitudinal straightedge shows deformation

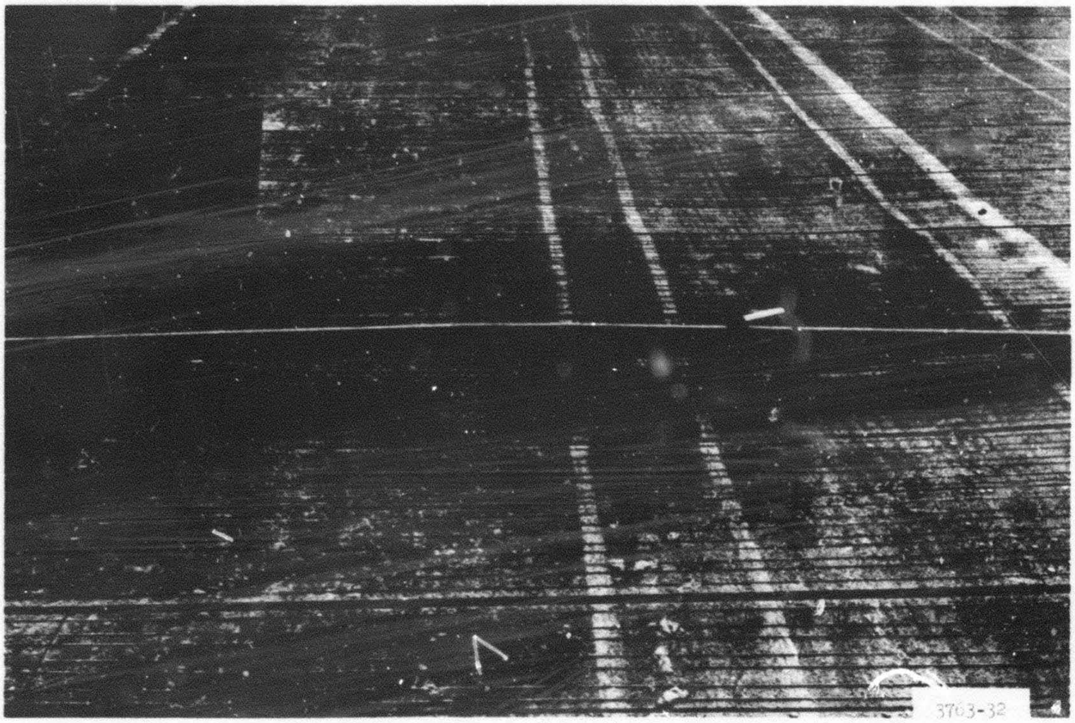


Figure 14. Lane 2, item 3, at 40 coverages (failure). Transverse straightedge shows deformation

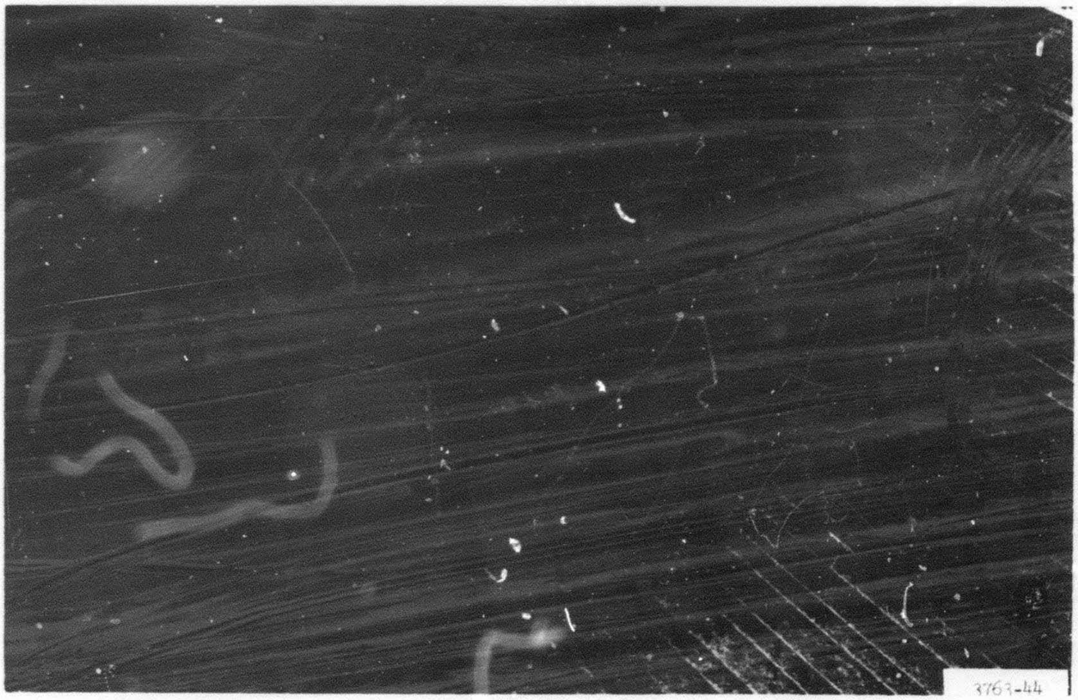


Figure 15. Lane 2, item 3, failed area at 68 coverages (28 postfailure coverages)

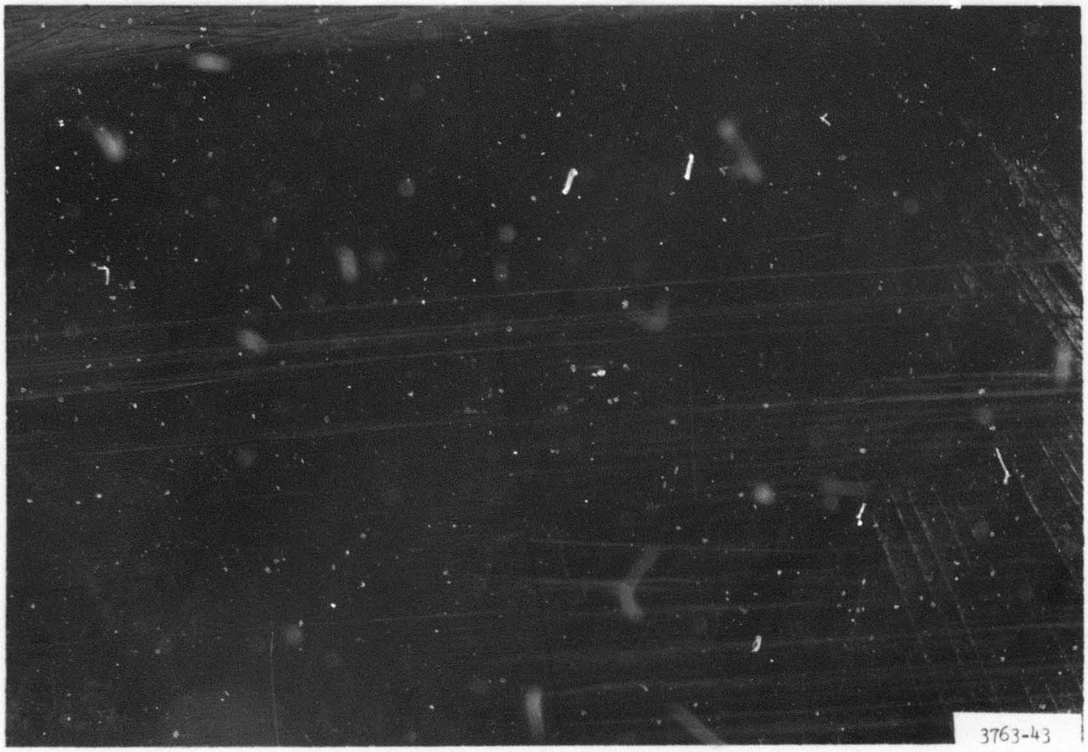


Figure 16. Lane 2, item 3, at 68 coverages (28 postfailure coverages). Longitudinal straightedge shows roughness and mat deformation

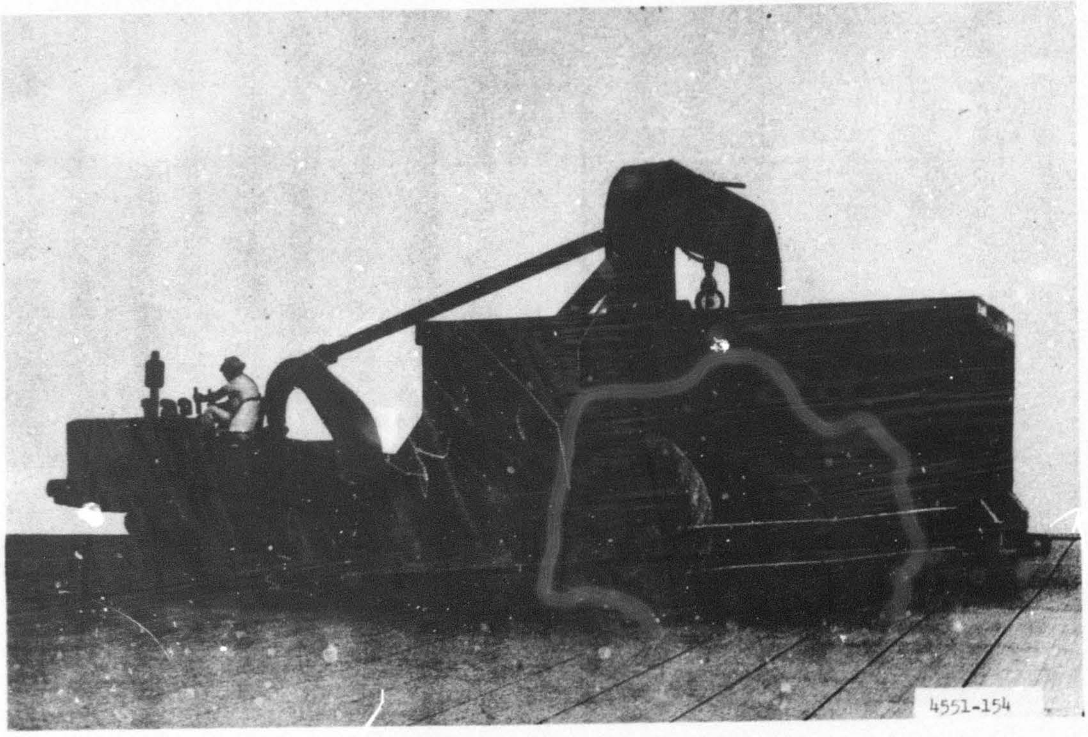


Figure 17. Test load vehicle

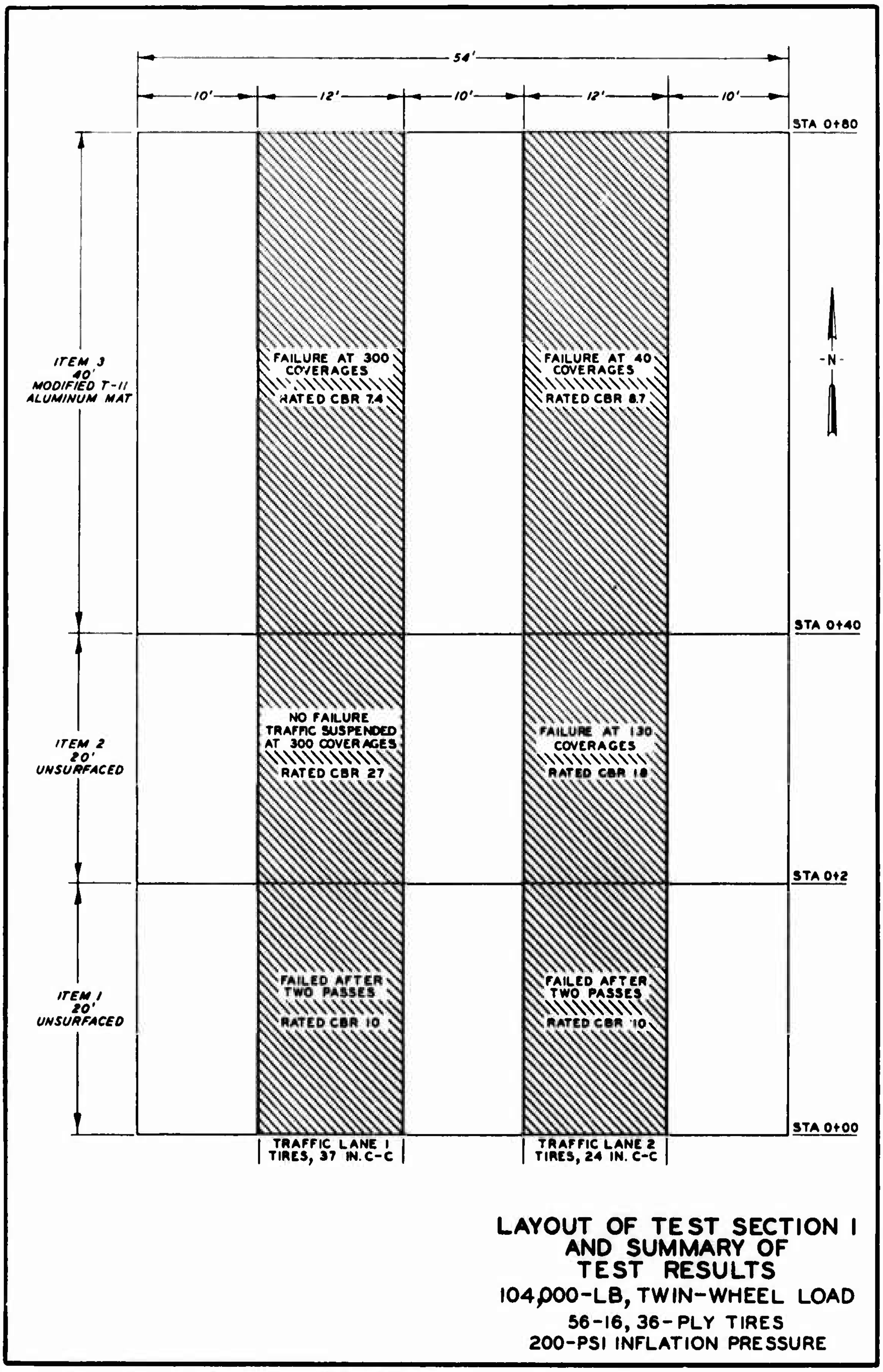

54'
10'
12'
10'
12'
10'
STA 0+80
STA 0+40
STA 0+2
STA 0+00
ITEM 3
40'
MODIFIED T-11
ALUMINUM MAT
ITEM 2
20'
UNSURFACED
ITEM 1
20'
UNSURFACED
FAILURE AT 300 COVERAGES
RATED CBR 7.4
FAILURE AT 40 COVERAGES
RATED CBR 8.7
NO FAILURE
TRAFFIC SUSPENDED
AT 300 COVERAGES
RATED CBR 27
FAILURE AT 130 COVERAGES
RATED CBR 18
FAILED AFTER TWO PASSES
RATED CBR 10
FAILED AFTER TWO PASSES
RATED CBR 10
TRAFFIC LANE 1
TIRES, 37 IN. C-C
TRAFFIC LANE 2
TIRES, 24 IN. C-C
-N-
LAYOUT OF TEST SECTION 1
AND SUMMARY OF
TEST RESULTS
104,000-LB, TWIN-WHEEL LOAD
56-16, 36-PLY TIRES
200-PSI INFLATION PRESSURE

Figure 18

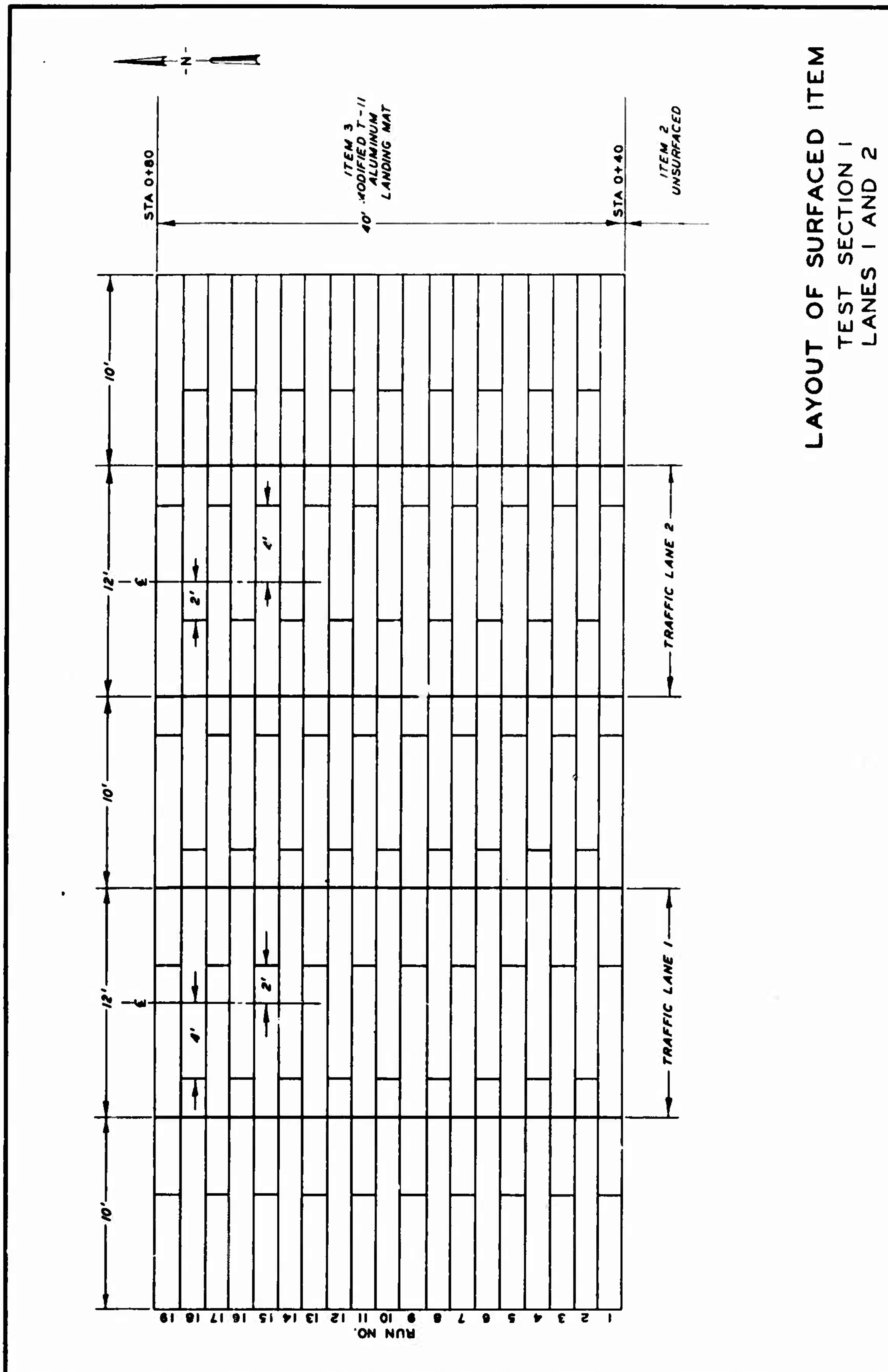
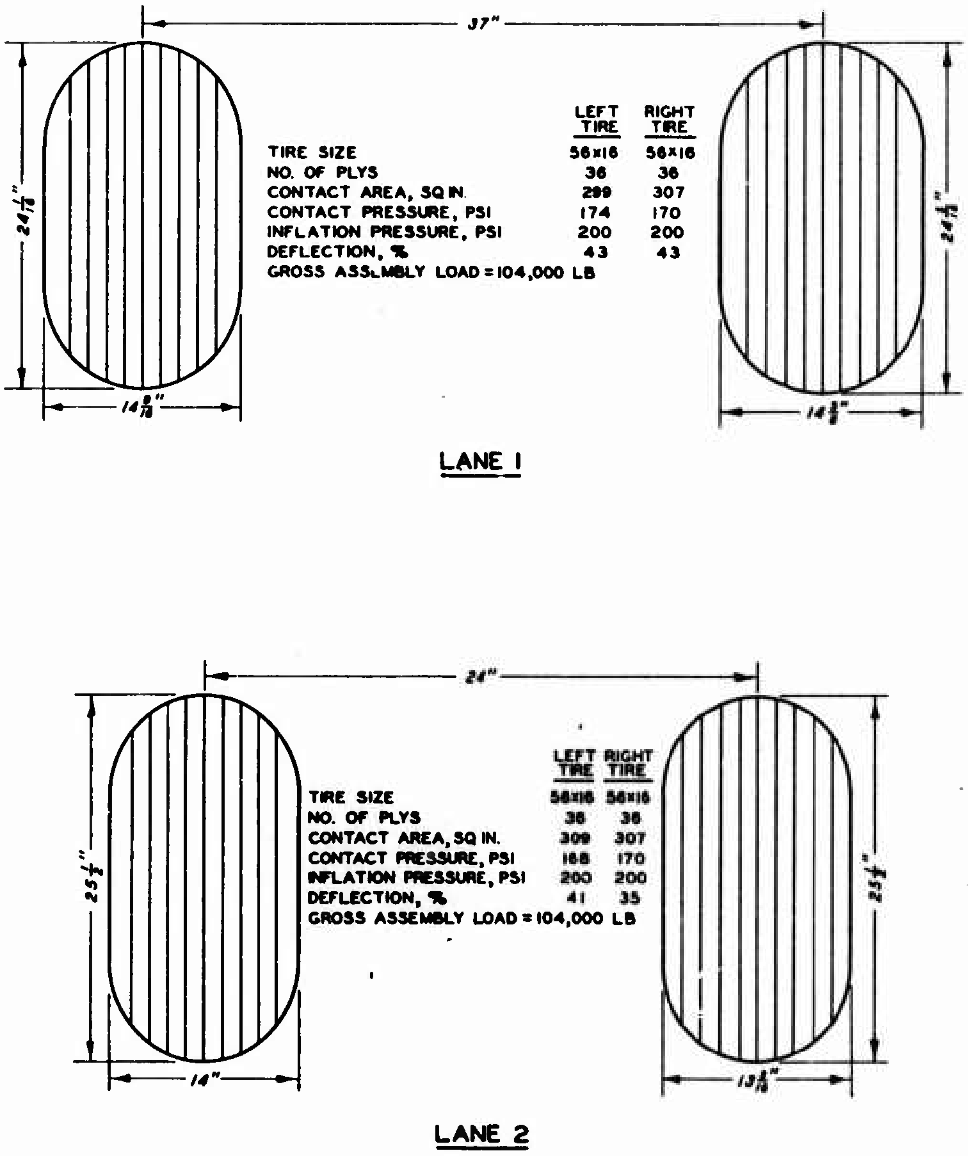

LAYOUT OF SURFACED ITEM
TEST SECTION 1
LANES 1 AND 2
N
ITEM 3
MODIFIED T-11
ALUMINUM
LANDING MAT
ITEM 2
UNSURFACED
STA 0+80
STA 0+40
40'
10'
12'
10'
12'
10'
2'
4'
TRAFFIC LANE 1
TRAFFIC LANE 2
RUN NO.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

Figure 19



TIRE-PRINT DIMENSIONS AND
TIRE CHARACTERISTICS

TEST SECTION 1
LANES 1 AND 2

Figure 20

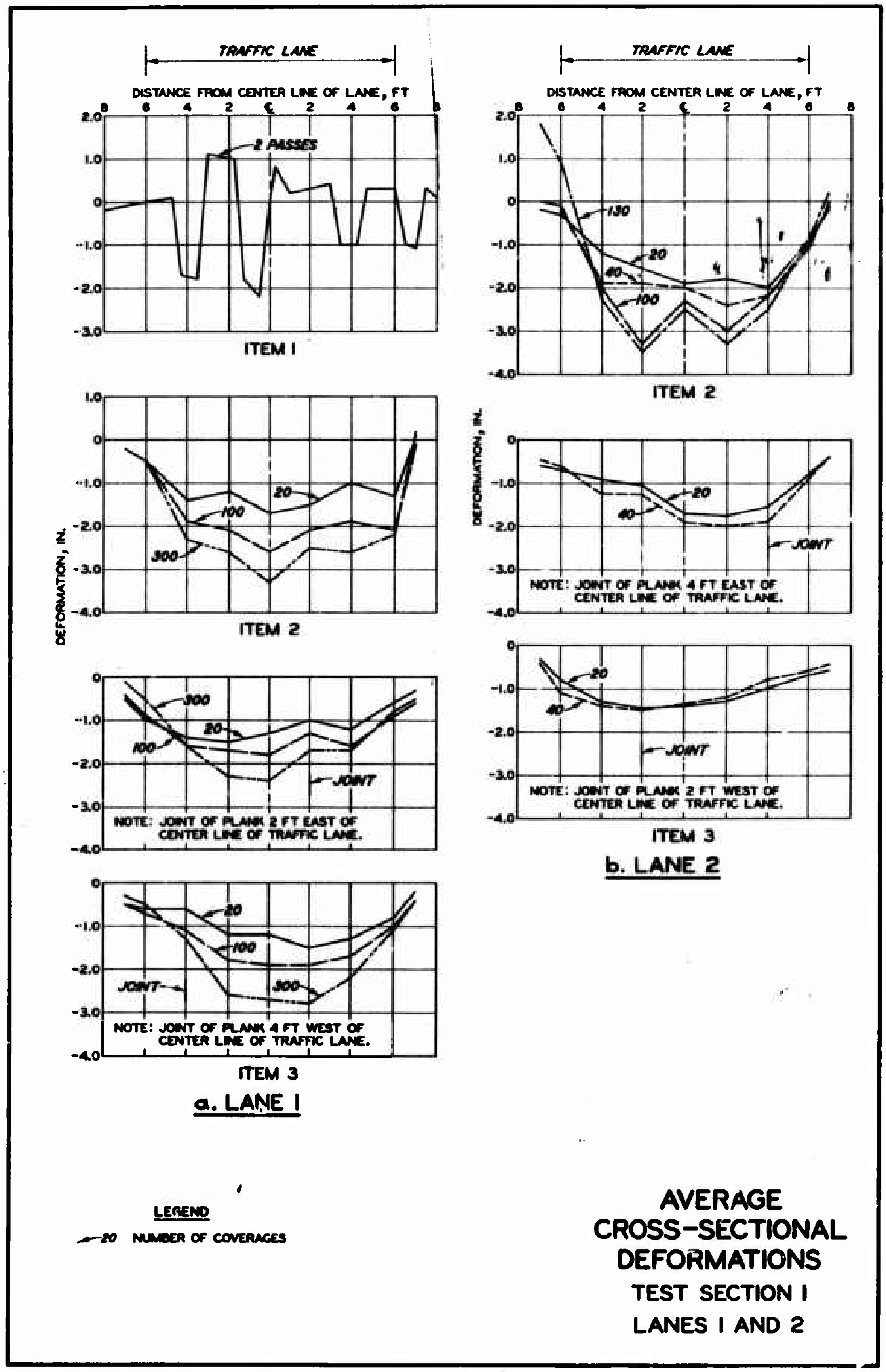

TRAFFIC LANE
DISTANCE FROM CENTER LINE OF LANE, FT
DEFORMATION, IN.
2 PASSES
ITEM 1
ITEM 2
NOTE: JOINT OF PLANK 2 FT EAST OF CENTER LINE OF TRAFFIC LANE.
JOINT
NOTE: JOINT OF PLANK 4 FT WEST OF CENTER LINE OF TRAFFIC LANE.
ITEM 3
a. LANE 1
NOTE: JOINT OF PLANK 4 FT EAST OF CENTER LINE OF TRAFFIC LANE.
NOTE: JOINT OF PLANK 2 FT WEST OF CENTER LINE OF TRAFFIC LANE.
b. LANE 2
LEGEND
20 NUMBER OF COVERAGES
AVERAGE CROSS-SECTIONAL DEFORMATIONS
TEST SECTION 1
LANES 1 AND 2

Figure 21

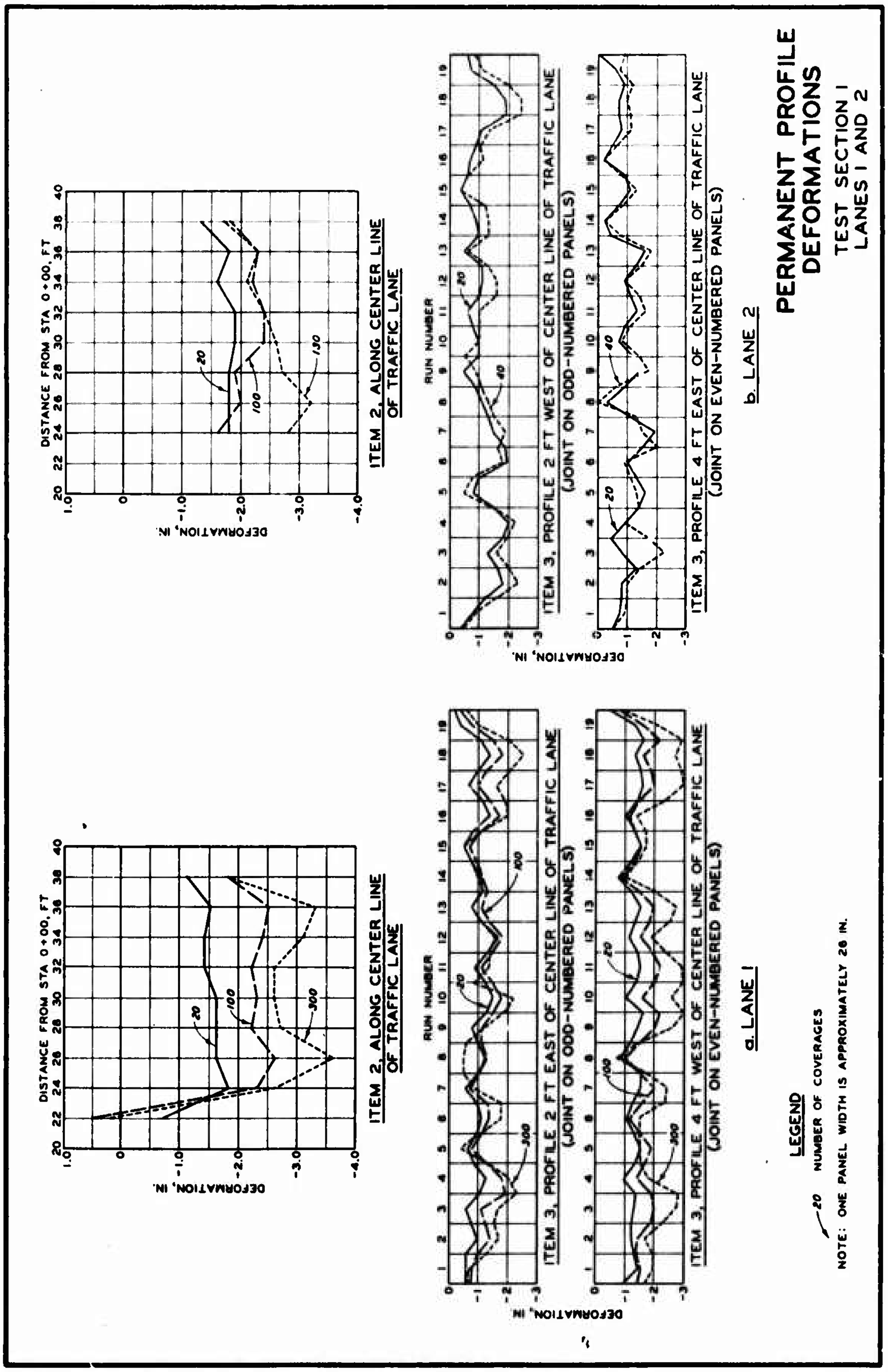
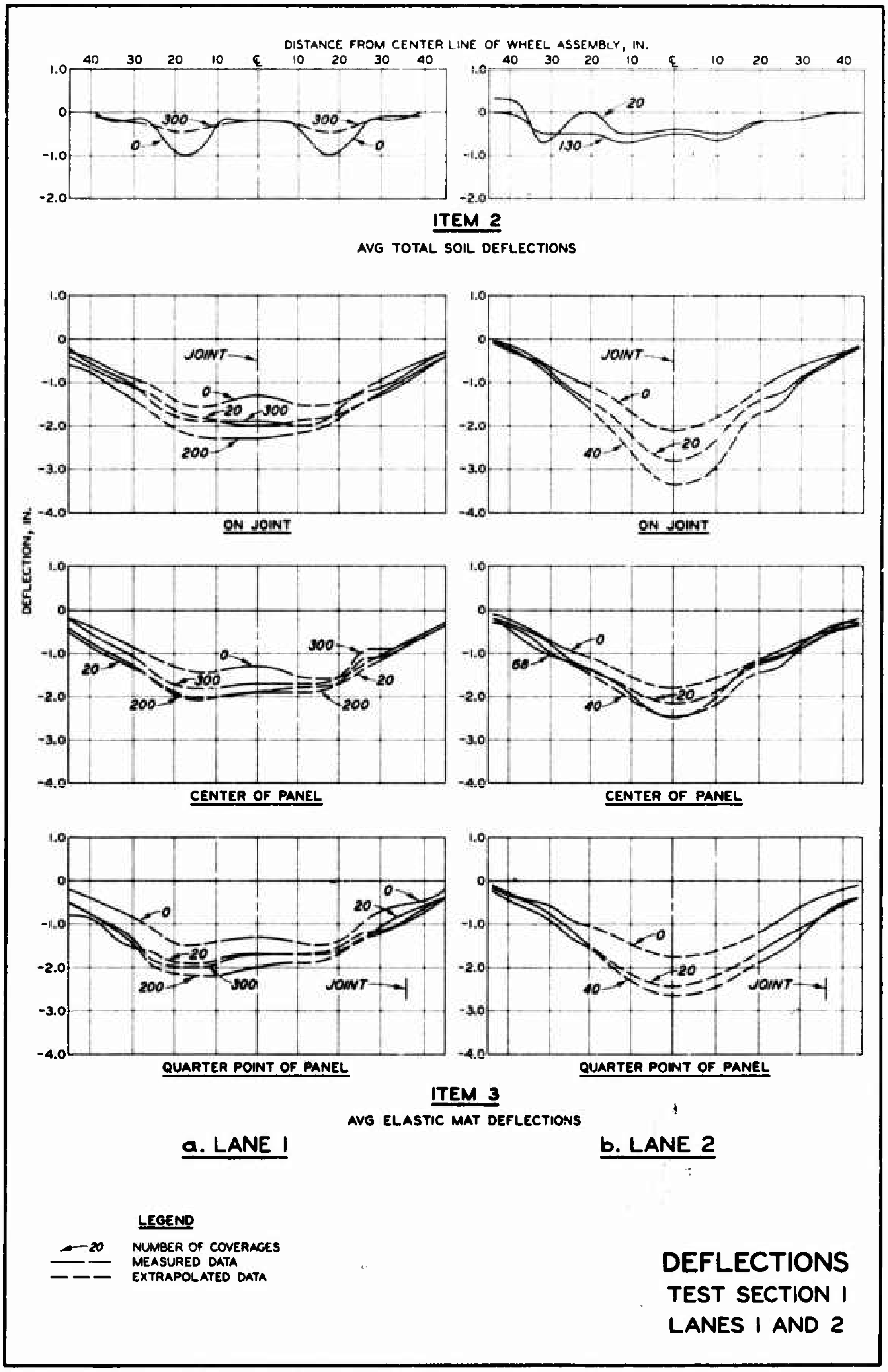

PERMANENT PROFILE DEFORMATIONS
TEST SECTION I
LANES I AND 2
a. LANE I
b. LANE 2
ITEM 2, ALONG CENTER LINE OF TRAFFIC LANE
ITEM 3, PROFILE 2 FT EAST OF CENTER LINE OF TRAFFIC LANE (JOINT ON ODD-NUMBERED PANELS)
ITEM 3, PROFILE 4 FT WEST OF CENTER LINE OF TRAFFIC LANE (JOINT ON EVEN-NUMBERED PANELS)
ITEM 3, PROFILE 2 FT WEST OF CENTER LINE OF TRAFFIC LANE (JOINT ON ODD-NUMBERED PANELS)
ITEM 3, PROFILE 4 FT EAST OF CENTER LINE OF TRAFFIC LANE (JOINT ON EVEN-NUMBERED PANELS)
DISTANCE FROM STA 0+00, FT
DEFORMATION, IN.
RUN NUMBER
LEGEND
20 NUMBER OF COVERAGES
NOTE: ONE PANEL WIDTH IS APPROXIMATELY 28 IN.

Figure 22



DISTANCE FROM CENTER LINE OF WHEEL ASSEMBLY, IN.
ITEM 2
AVG TOTAL SOIL DEFLECTIONS
DEFLECTION, IN.
JOINT
ON JOINT
CENTER OF PANEL
QUARTER POINT OF PANEL
ITEM 3
AVG ELASTIC MAT DEFLECTIONS
a. LANE 1
b. LANE 2
LEGEND
20 NUMBER OF COVERAGES
MEASURED DATA
EXTRAPOLATED DATA
DEFLECTIONS
TEST SECTION 1
LANES 1 AND 2

Figure 23

UNCLASSIFIED

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(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) U. S. Army Engineer Waterways Experiment Station	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b GROUP

3. REPORT TITLE

Aircraft Ground-Flotation Investigation
Part II Data Report on Test Section 1

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Final Technical Report

5. AUTHOR(S) (Last name, first name, initial)

Brabston, W. N.
Rutledge, A. H.
Hill, W. J., Jr.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Air Force Flight Dynamics Laboratory Research and Technology Division AF Systems Command, WPAFB, Ohio

13. ABSTRACT

This data report describes the results of work undertaken as part of an overall program to develop ground-flotation criteria for the C-5A aircraft.

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Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT

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